REMR Technical Note OM-MS-1.4
(Supersedes OM-MS-1.4 1991)

REMR Management System for Steel Sheet-Pile Structures

Purpose

This technical note provides information about the REMR Management System for steel sheet-pile structures.

Background

The U.S. Army Corps of Engineers is responsible for maintaining a large number of lock and navigation facilities. To assist those involved in planning and budgeting for maintenance and rehabilitation (M&R) of these facilities, a series of REMR Management Systems is being developed. These computerized maintenance management systems should provide improved and more consistent methods for life-cycle cost comparisons of M&R alternatives and more effective means for monitoring the condition of facilities (see REMR Technical Note OM-MS-1.1).

Overview

A REMR Management System has been developed for steel sheet-pile structures. Like the other REMR Management Systems, this one contains standardized inspection and condition rating procedures, life-cycle cost-analysis routines, and data storage and handling capabilities. The system also includes software for performing required calculations and for producing a variety of reports for work planning and budgeting purposes.

As with the other REMR Management Systems, the primary driving element is the condition rating process. The condition ratings used in this system follow the standard REMR condition index (CI) scale, as described in REMR Technical Note OM-CE-1.2.

Application of this management system begins with an inspection of a steel sheet-pile structure according to the standard procedure established for the system. This inspection information is entered into the system to determine the functional CI, the structural CI, and finally, an overall CI for the whole steel sheet-pile structure.

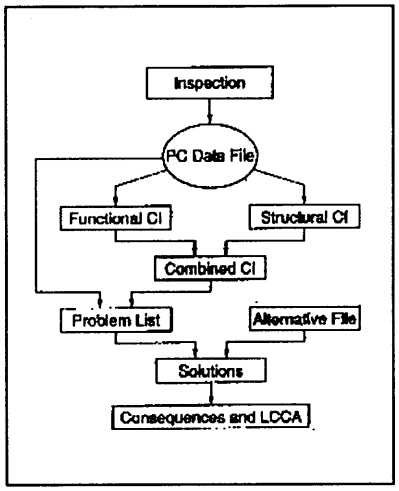

Figure 1. Schematic of M&R analysis of steel sheet pile

Next, various alternatives are formulated into a set of M&R solutions. The program will then provide consequences for these alternatives and perform a life-cycle cost analysis for each. This process is illustrated in Figure 1.

Condition Index

The CI is primarily a planning tool with the index values serving as an indicator of the general condition level of the structure. The index is meant to focus management attention on those structures most likely to warrant immediate repair or further revaluation. In addition, the CI values can be used to monitor change in general condition over time and can serve as an approximate comparison of the condition of different structures.

Functional CI

The functional CI is based on field measurements and observations of structure defects. It includes both safety and serviceability considerations. These filed measurements are related to a list of eight functional distresses listed in Table 1. As an example, a misalignment, X, of 6 in. could be measured at a lock guide wall. If the limiting value of this movement, X_{max}, is 9 in. (X/X_{max} = 0.67), observation of Figure 2 gives a functional CI near 54. This is a Zone 2 condition in which an economic analysis of different repair alternatives is recommended. A similar procedure is used for the other distresses shown in Table 1. The CIs for the individual distresses are combined by a weighted average to give the overall functional condition of the steel sheet-pile structure.

Structural CI

The structural CI is a measure of the safety of the structure or its risk of failure. It is based directly upon the calculation of a factor of safety (FS) of the existing state of the structure. A basic part of the structural safety evaluation is a structural analysis. The U.S. Army Corps of Engineers' design manuals serve as the basis for the analysis procedure of steel sheet-pile structures. These sources are supplemented by a U.S. Army Corps of engineers' computer program. Software was written to help analyze cantilevered walls, anchored walls, cellular walls, and single cells. FSs are computed for several failure modes; for example, anchored walls consider three failure modes: sheet bending, anchor tension, and soil failure at the toe. As an

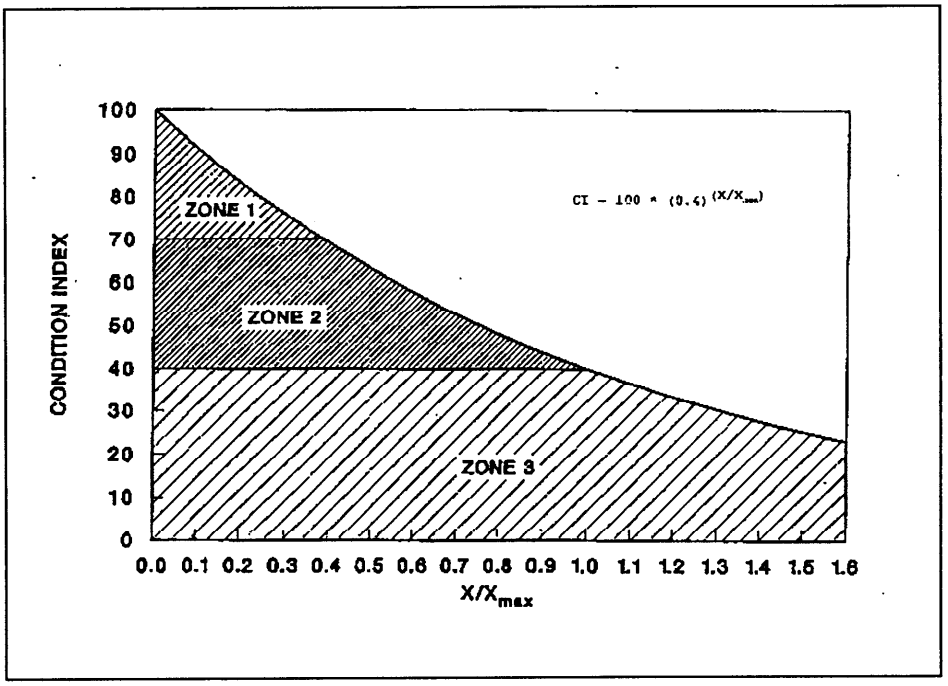

Figure 2. Functional CI related to X/X_{max}

example, if the actual FS of a failure mode were greater than its design FS (2.0 for normal load cases), that structural CI would be 100. As the actual FS approaches 1, the structural CI becomes 40, a Zone 3 condition recommending further evaluation and eventual repair. The product of the CIs for each failure mode gives the overall structural condition of the steel sheet-pile structure (Greimann and Stecker 1989).

Table 1
Distresses in Steel Sheet-Pile Structures

Distress Code	Distress	Brief Description
1	Misalignment	Horizontal or vertical deviation from the design alignment
2	Corrosion	Loss of steel caused by interaction with environment
3	Settlement	Vertical movement of material behind sheet pile
4	Cavity formation	Loss of fill material
5	Interlock separation	Failure of sheet interlocks
6	Holes	Broad opening in sheet
7	Dents	Depression in sheet without rupture
8	Cracks	Narrow break in sheet

M&R Analysis

The structural and functional problems detract from the performance (safety and/or serviceability) of the structure. After the problems have been identified, several different M&R solutions or strategies can be formed. The consequences of each solution are obtained by calculating a new CI that reflects the as-repaired structure. Life-cycle cost information about the solution can provide a preliminary evaluation of a maintenance plan (Greimann and Stecker 1990).

References

Greimann, L., and Stecker, J. (1989). "User's Manual: Inspection and Rating of Steel Sheet-Pile Structures," Technical Report REMR-OM-3, U.S. Army Construction Engineering Research Laboratories, Champaign, IL.

Greimann, L., and Stecker, J. (1990). "Maintenance and Repair of Steel Sheet-Pile structures," Technical Report REMR-OM-9, U.S. Army Construction Engineering Research Laboratories, Champaign, IL.